

A Pilot Computer-Aided Design and Manufacturing Curriculum that Promotes Engineering

A. INTRODUCTION

Elizabeth City State University (ECSU) is located in a community that is mostly rural in nature. The area is economically deprived when compared to the rest of the State. Many businesses lack the computerized equipment and skills needed to propel upward in today's technologically advanced society. This project will close the ever-widening gap between advantaged and disadvantaged workers as well as increase their participation with industry, NASA and/or other governmental agencies.

Everyone recognizes computer technology as the catalyst for advances in design, prototyping and manufacturing or the art of machining. Unprecedented quality control and cost-efficiency improvements are recognized through the use of computer technology. This technology has changed the manufacturing industry with advanced high-tech capabilities needed by NASA. With the ever-widening digital divide, we must continue to provide computer technology to those who are socio-economically disadvantaged.

B. ENROLLMENT DATA

<u>Courses Taught (In less than 2 years)</u>	<u># of Students/Participants</u>
Computer Aided Manufacturing	5
ThermoSystems	8
Machine Design	8
Computer Applications	32
Electro-Mechanical Control	12
Senior Projects	10
Research in Industrial Technology	2
Computational Science-Scientific	24
Visualization Summer Institute	
Summer Transportation Institute	40
LabView Workshop	<u>24</u>
Total Students/Participants:	165

Faculty Involvements:

- 1) Two faculty members attended the PTC training in Pro/E and Pro/M
- 2) Three faculty members used the Lab for instruction
- 3) Four faculty members attended the LabView workshop
- 4) Eight faculty members, eight graduate students and eight undergraduates attended the workshop for the Computational Science-Scientific Visualization Summer Institute.

C. OUTCOMES

The goal of this project is to expose students and NASA employees to concurrent engineering through computer-aided design, rapid prototyping and computer-aided manufacturing, which is used in the product development process.

Objective 1: To identify an innovative CAD tool and training activity that will optimize the product development process thus enhancing NASA's mission.

Objective 2: To provide courseware that offers the latest training on new software products and enhancements to continually promote the curriculum development process. The following courseware and/or software has been purchased:

- 1) Catalyst to enhance rapid prototyping developed by Stratasys Inc.
- 2) CADTRAIN Coach for CAD that covers the Pro/E milling and turning for manufacturing.
- 3) CADTRAIN Coach for Pro/E also provided milling and turning for manufacturing.

CADTRAIN courseware is used to help participants to continually increase their knowledge and skills in CAD/CAM. The courseware assures mastery of subject matter by offering pre- and post- course assessments. The methodology includes adaptive questions mapped to each learning objective. Self-paced courses delivered to the workstation using the Internet takes into account individual differences.

Presently, two instructors from ECSU have attended four workshops in *Introduction to Pro/E, Fundamentals of Design and Fundamentals of Pro/M*.

Objective 3: To capitalize on combined expertise of PTC instructors. (NASA employers and ECSU personnel collaborated to provide broad experiences in designing and tailored training solutions, which met the unique needs of NASA and industry).

PTC provided training for ECSU employees, in addition, NASA provided a technical support person to assist in Pro/E and CAM training. The personnel in the stereolithography lab (SLA) at NASA/LaRC aided in SLA and rapid prototyping training. The combined efforts made it possible for the instructors at ECSU to teach the product development process found in industry. As part of the partnership Haas has provided equipment at affordable prices. In addition they provided funding for a four-day workshop on CNC milling for the principal investigator of this project. This training reduced the learning curve for students and faculty.

Objective 4: To provide practical lectures from instructors and challenging, hands-on labs that accelerates the learning curve for CAD/SLA/CAM.

The instructors at ECSU have provided the following lectures in Pro/E to STI participants: Computation Science, Scientific Visualization Summer Institute as well as the following classes: Thermo Systems, Machine Design, Computer Application, Electro-Mechanical, Senior Project and Research in Industrial Technology and computer aided manufacturing. The introduction of

rapid prototyping made it possible for the participants to develop a functional model of their designs.

Note: The first Institute (summer 2000) required the participants to develop their model or prototype in NASA/LaRC Stereolithography (SLA) Lab. (See picture of students with prototype on page 8) During the second Institute (summer 2001), the participants were able to prototype their models at ECSU CAD/Rapid Prototyping/CAM Lab.

Objective 5: To provide on-site training in CAD/CAM that will involve participants from NASA, the socially and economically disadvantage students in this county.

The CAD training has been provided mostly for students from northeastern North Carolina, which is the poorest section of the state. The rapid prototyping and CAM equipment was installed July 2001 and December 2000 respectively. The rapid prototyping is being introduced in the Computer Applications course during the Fall of 2001. The CAM or Haas CNC mill training is being introduced in the Computer Manufacturing course during the Fall of 2001 for participants who are comprised of mostly economically disadvantaged youth.

Objective 6: To provide the participants with the skills needed to enhance competitive advantage using CAD/CAM tools that encourages concurrent engineering.

The software solutions developed by PTC will help manufacturers get superior products to market before their competitors. Mastery of PTC software (CAD) takes you directly to prototyping and CAM or through the development process with an added edge.

Objective 7: To provide the participants a recommended path for training in CAD/CAM.

The instructors at ECSU and the technical support persons from NASA/LaRC have had training in the use of PTC software. As a result, ECSU instructors are currently teaching courses in Pro/E and Pro/M, which take participants through the product development process.

EVALUATION ACTIVITIES

The evaluation for the courses taught in the CAD/Rapid Prototyping/CAM Lab funded by NASA Partnership Award was completed by students and the Technology Department chairperson. The evaluations by the students were at least 4 on a 5-point scale. The chairperson's evaluation was 495 points out of a possible 500 points overall.

The May 14-25, 2001 Summary Participants Evaluation of The ECSU Scientific Visualization Summer Institute In Computational Science, funded by the Department of Energy, had certain items on it's evaluation form related to skills obtained by conducting research in the NASA funded CAD/Rapid Prototyping and or Stereolithography/CAM Lab. The item ratings were highly in favor (4.7) on a 5 point scale) of the lab as a physical facility technologically advanced to aid in scientific visualization in computational science.

The Summer Transportation Institute, funded by the Federal Highway Administration, overall program evaluation form was rated highly by the participants. The portion of the evaluation that dealt with CAD(Pro/E) and Stereolithography for the first institute and rapid prototyping for the second institute is available upon request.

D. PARTNERSHIPS

ADDITIONAL FUNDING SOURCES FROM PARTNERS

The Summer Transportation Institute was funded by FHWA for 100K for two 4-week summer institutes. ECSU has paid 50K for the infrastructure; PTC has provided 25 seats of Pro/E for 30K that would have cost 32K per seat. Haas manufacturer has provided a CNC mill and lathe for 106K that would have cost 122K Title III has provided 120K to the development of the CAD/SLA/CAM. The 50K from NASA Kennedy Space Center for fiber optic networking provided for partial networking of the Lab.

Partnering with Parametric Technology Corporation has made it possible for ECSU to purchase 25 seats of the software with training for \$30,000. ECSU, a minority institution, offers training in Pro/E and Pro/M similar to what is being offered at the majority institutions. Funding of this project makes it possible for the university to conduct related research for NASA and industry. Parametric Technology Corporation, partnering with ECSU, has provided training in Pro/E and Pro/M for the Technology Department faculty at ECSU and the College of the Albemarle (COA) at no cost.

The normal cost for this training ranges from \$1,500 to \$2,000 per week. PTC offers over twenty (20) workshops on different topics needed in product development process.

CADTRAIN partnered with ECSU and provided the software for the university at a cost of \$5000 for departmental license. *(No upgrades are provided.)*

RELATED RESEARCH

- North Carolina Department of Transportation Pre-Employment Training workshop
- Summer Transportation Institute for high school students emphasizing algebra, trigonometry, geometry, and computer-aided design using Pro/E, rapid prototyping and Stereolithography. Coverage included Pro/E and Pro/M.

E. ISSUES AND CONCERNS

When the proposal was written, the Principal Investigator did not realize the amount of time required for purchasing equipment under the North Carolina University System, consequently, the project has just reached the point where the goals and objectives can be fulfilled for this endeavor. The planned time frame should have been extended six months for obtaining equipment and supplies. Purchase of up to date equipment, software and hardware has made it possible for the University to now compete for contracts with governmental agencies and/or industries. Before we received this award, we could only compete for grants. *(Note: this could be viewed as an outcome as well as a concern).*

Note: The following two paragraphs of this NASA final report will be forwarded to the insurance company and the appropriate University officials.

In an attempt to become self-sufficient the University will offer the training in Pro/E, Pro/M Prototyping and CAM. As spelled out in the proposal it was scheduled to teach Pro/E and Pr/M during the summer 2001. The workshops were to be advertised on the ECSU Web page and radio station. We plan to obtain participants from the U.S. Coast Guard, industry and teachers. The teacher normally would not teach during this time frame. There should have been a number of teachers needing re-certification and these workshops would have offered continuing educator credit. This plan was cancelled because a roofing contractor failed to take the precautions needed to protect the lab. As a result we had to cancel the workshops. The estimated loss to equipment was 28K. The PI was able to bring the equipment and lab back on line to conduct two institutes.

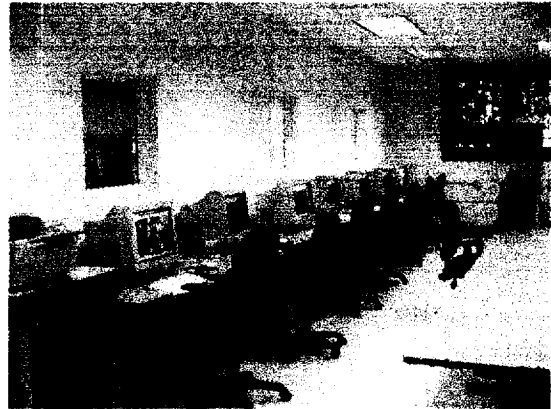
The partnership has made it possible for the lab to function and has moved us toward becoming self-sufficient. As with any partnership there are concerns. The University has appropriate funds with assistance from Title III. Based on these appropriations, there appears to be a move to use the labs for academic classes 100% of the time as opposed to what is dictated in the proposal by the PI. We have compromised and the partners are satisfactorily accommodated. In sum, the project is a success.

LABORATORY BEFORE PROJECT FUNDING



Before the university received the Partnership Award from NASA the lab was non-computerized. Note: No students and the inability to compete for contracts and grants.

LAB AFTER PARTITION



Fifteen CAD workstations, server, printer, plotter, rapid prototyping machine, digital camera, digital projector, television and stand; a partition was built to separate the CAD Lab from the CAM Lab.

COMPUTER AIDED MANUFACTURING LAB AFTER RECEIVING PARTNERSHIP AWARD



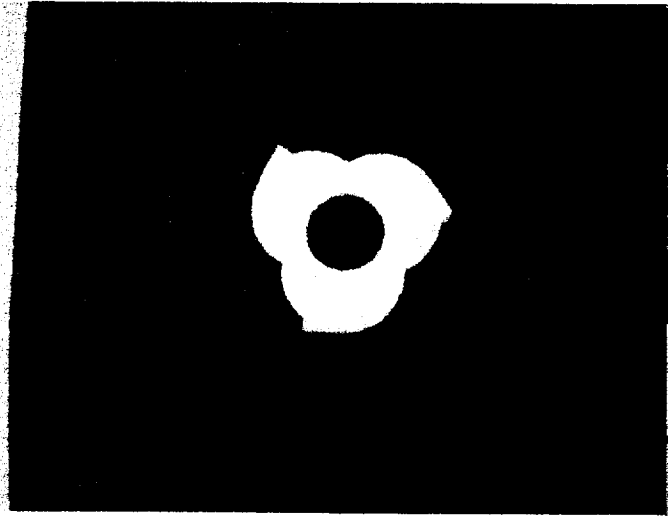
Sand blaster, band saw, storage area, safety cabinet, cnc mill. Note: a CNC lathe will be installed in this lab on September 5, 2001.

PHASE 1 OF THE PRODUCT DEVELOPMENT PROCESS



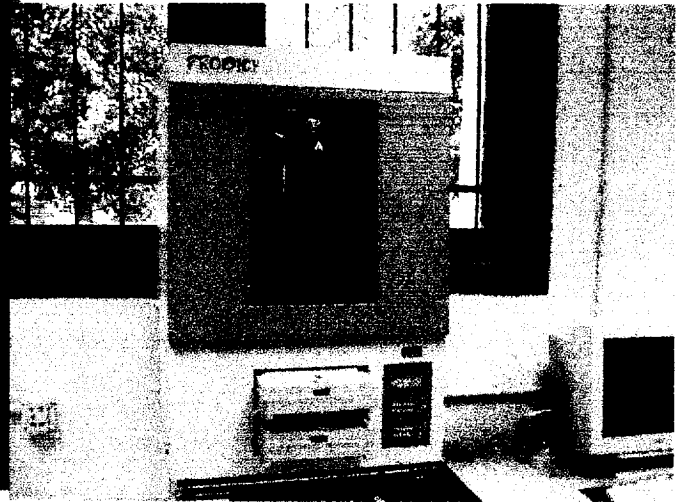
The university has gone from a non-computerized lab to a totally computer controlled lab in areas of computer aided design, computer aided prototyping and computer aided manufacturing. Students are now offered relevant experiences. Observe the model (cutter) on the computer screen being designed by the young lady on the right. That model was prototyped the next day on rapid prototyping machine out of abs material and made available for testing and evaluation in less than two hours.

CUTTER



Here we have a cutter built out of abs material on the prototyping machine found on the next page.

PHASE 2 OF THE PRODUCT DEVELOPMENT PROCESS



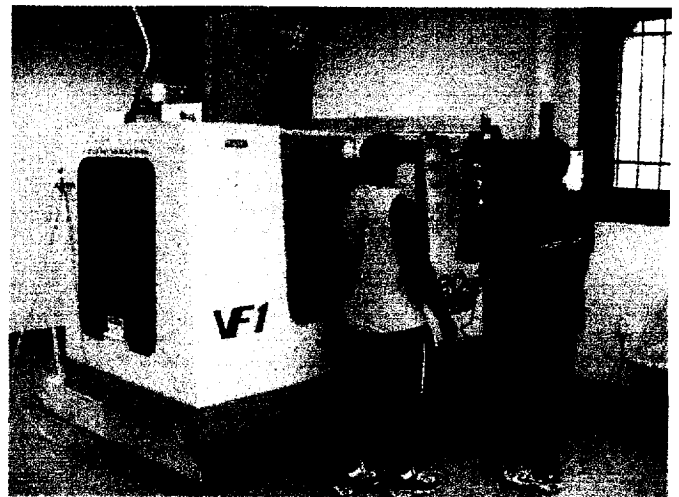
Computer controlled rapid prototyping machine
Once the design has been prototyped and evaluated, it goes to the manufacturing phase.

COMPUTER AIDED MANUFACTURING LAB AFTER RECEIVING THE PARTNERSHIP AWARD



Sand blaster, band saw, storage area, safety cabinet,
CNC mill Note: A CNC lathe will be installed in this
lab on September 5, 2001

PHASE 4 OF THE PRODUCT DEVELOPMENT PROCESS



Students are manufacturing a part on the CNC mill
that was designed in the CAD Lab.

THE CAD/RAPID PROTOTYPING/CAM LAB



Pictured above are participants in the Summer Transportation Institute. The participants represent ninth, tenth and eleventh grade students.

COMPUTATIONAL SCIENCE- SCIENTIFIC VISUALIZATION SUMMER INSTITUTE



Pictured above are participants in the Computational Science-Scientific Visualization Summer Institute. Undergraduate and graduate students and professors participated.

Proto-type Built In NASA/LaRc/SLA Lab



Pictured Above: Students display a model designed using Pre/E in the NASA funded CAD/SLA/CAM Lab at ECSU.